

STUDYING HEAVY ARTILLERY FIRE BY PHOTOGRAPHY

Some of the Things Uncle Sam's Coast Defence Experts Have Learned With Aid of the Camera

By CLEVELAND MOFFETT.

THE swiftest thing that the human race has ever put in motion is the steel projectile of a 12-inch gun. No human eye can follow its flight. Released at a pressure of 40,000 pounds to the square inch—heat at which diamonds melt and other forms of carbon boil—it darts through the air at the rate of twenty-five miles a minute and reaches the mark ahead of its own sound!

One of the most progressive branches of our military service is the department of coast defence, which under the farseeing guidance of Gen. E. M. Weaver holds our shores and harbors in a state of alert preparedness against foreign aggression.

At Hampton Roads sits the coast artillery board, composed of officers and consulting engineers to whom are referred all problems relating to coast artillery and who have the responsibility of testing all new instruments proposed for artillery use. The purpose of this article is to describe one among several notable achievements of the Hampton Roads Coast Artillery School, this particular work having been done by Capt. F. J. Behr of the Coast Artillery Corps, who after years of effort has recently developed a system that makes it possible to take pictures of the swiftest moving bodies, the great steel projectiles of our biggest guns—to seize them with the camera's eye as they hurtle through the air at enormous velocities or at the very moment of their emergence from the gun muzzles, and to preserve these images, never seen before, for military study and comparison. Capt. Behr was ably assisted in this work by Engineer J. A. Wilson.

Some of the increments and decrements of time involved in the photographs herewith published are as small as 1-10,000th part of a second. And Capt. Behr has devised a method of taking photographs of projectiles as they arrive at a steel target and penetrate the target inch by inch that involve increments or decrements of time as small as the 100,000th part of a second.

To the uninitiated it seems incredible that such infinitesimal divisions of time can be used in practical calculations, but every trained physicist knows that in wireless work scientists of to-day speak casually of experiments that take account of two-tenths or one-tenth of a millionth part of a second!

What happens to the projectile after it leaves the gun, or after the discharge of the gun and before the projectile has had time to issue from the gun barrel? What is the action at the muzzle of gases generated? What shape do these gases assume as they leave the gun? What causes the much discussed "gas rings" that sometimes form when a mortar is fired and often do not form? What phenomena attend the arrival of the projectile at a solid steel target? Is the steel actually fused by the heat of impact? Is it vaporized? Or what?

These are some of the questions that Capt. Behr set himself to solve, or to help in solving, as he worked out his methods of rapid photography. His aims were strictly military, but his results make fascinating appeal to the general imagination. Fancy doing anything in the one hundred thousandth part of a second!

Capt. Behr's general idea was to utilize some phenomenon connected with the discharge to actuate, by electrical connections, a mechanism that would work a rapid shutter in a properly placed camera.

The phenomenon of concussion was

tried first—the smash of air against a little swinging door; but this was much too slow. The projectile was hundreds of yards away before the camera had registered its picture. And the chance was gone!

In the next trial, several months later, Capt. Behr arranged to have the electrical connections made or broken by the movement of the gun carriage itself in recoiling; but the result was unsatisfactory.

Nor was he more fortunate at the succeeding target practice, when, having placed the apparatus further forward on the parapet, he had the camera demolished by the force of the concussion and several blades of the rapid shutter broken.

He was satisfied now that his effort to actuate the camera mechanism from the gun carriage would never give the requisite precision in results, and he saw that he must work with a device functioning more reliably.

In the months that followed before the next target practice the Captain did some experimenting and finally determined making the projectile itself displace a length of piano wire fixed across the muzzle of the gun and thus actuate the electrical system and operate the shutter.

In this way he eliminated troublesome variables of recoil, elasticity of the carriage, &c., leaving to determine only the time element of the electrical system to function.

This result was admirable and after taking several similar pictures the Captain found that he could now operate with great precision—that is, he could get the same phase of the discharge with almost identical shapes of gas cone and smoke cloud and he could get these every time.

In the fall of 1912 Capt. Behr succeeded in obtaining a series of extremely rapid photographs showing a 12 inch mortar battery in action. In taking these pictures the camera was placed on an elevation about ten feet above the concrete floor and about sixty feet back of the mortars. The electrical device for working the shutter was actuated by the mortar itself in its recoil. These pictures were taken in about one five thousandth of a second.

So great was the precision of the electrical device as to render possible the photographic recording of these mortar projectiles, moving at great velocities, in almost any desired position after the discharge, say two feet away from the muzzle, or six feet away, or twenty feet away, or right at the muzzle.

It is interesting to note that the strange "powder-puff" effect is never seen, and although the crashing explosion has taken place and the projectile is already started on its long journey, the men (even the lanyard man, who is nearest) have heard nothing, since the sound waves have not yet had time to reach their ears. Nor has the mortar itself had time to recoil, as it does presently, down into the well in the floor of the pit.

The men aboard the towing vessels that drag the floating targets during gun and mortar practice would seem to be in a dangerous position, since the tow line is not more than 200 yards long for guns and 500 yards for mortars, and a very slight error in aim or adjustment might cause a deviation of several hundred yards when the range is eight or ten thousand yards.

As a matter of fact, such errors do not occur, and a gun pointer who would make a right or left deviation from the target of ten yards, or at the most fifteen yards, and a distance of five miles, would be considered unfit for his job.



The "powder puff" effect. The projectile still hidden in the smoke cone.

In one or two rare instances a towing vessel has been struck when a projectile has fallen short and then recoiled over the waters as a pebble skips along owing to its rotation in that direction. The rifling of the gun barrel causes this rotation.

Sometimes these great projectiles ricochet several times, and go bounding over the waters as a pebble skips along the surface of a mill pond, only there may be a distance of a mile or more between these giant leaps.

A strange phenomenon is witnessed by the observer on a towing vessel as he looks, rather uneasily perhaps, toward the distant shore battery, that seems to be firing straight at him.

Owing to the great velocity of gun

course of the river, under the Williamsburg Bridge, through treacherous Hell Gate and on into the wide waters of the Sound. After some three hours or so we landed at Hart's Island. It was a cheerless, rainy day, and the long, low lying island looked bleak and desolate. Down at the dock four convicts, with slickers over their striped suits, were waiting for us. We steamed slowly up and made fast, the gangplank was run out, and the convicts tossed a long rope down the plank, with a pair of ice hooks attached to the end of it.

After a moment some one on the boat gave the word, the convicts put their shoulders under the rope and a second later a long, red painted box, rudely shaped like a coffin, went sliding up the gangplank and jolted down into the wet dock. Another followed, and another. Some of the smaller coffins, containing the ladies, were tossed from the deck of the boat up to the men on the dock. For a half hour this unloading went on until the boat was empty and its cargo was piled on the landing in a clumsy monument.

The crew washed down the decks with a hose. A big, black covered wagon had come down to the dock and the coffins were placed in it, to be taken out into the fields and buried three or four deep in a long trench, each labelled for future reference.

Capt. Hayes reached up and gave a yank at the whistle, the lines were cast off, the door on the black wagon banged shut, a bundle of old newspapers hurtled through the air and was caught by one of the convicts just as we began to get under way. Two of the convicts stood on the dock in the drizzling rain and stolidly watched us swing out into the river and head for home. They were hard, grizzled men, seemingly void of emotion. Capt. Hayes waved his hand out of the window and a few moments later they were lost to view.

"It looks dreary enough now," remarked the captain, as he cast a look back at the island, "but in the summer it's not so bad. The grass grows all over the island in a soft, green carpet and makes a pretty sight."

I gazed back at the dark strip of land dotted with its tiny white tombstones.

"How many are buried there now, Captain?" I asked.

"Oh about 250,000 or 260,000," he replied. "You know, he went on, 'sometimes I think I wouldn't mind being buried there myself. After all, what difference does it make. Once you're dead, you're dead. Have some coffee?'"

The projectile almost out of the mortar. The gas ring is forming at its upper end.

Projectiles, it is almost impossible for an observer near the target to see them as they approach; but a trained eye can discern the slower moving mortar projectiles as they drop out of the sky, shrieking as they come, curving downward from a height of four or five miles, half a ton falling with tremendous velocity.

It is difficult to realize what an enormous force is released when one of these 12-inch guns is discharged. The pressure inside of the gun behind the projectile is between 35,000 and 40,000 pounds to the square inch.

No engine or machine made by man produces anything like this pressure in steam engines. In big turbines driven by superheated steam the pressure does not exceed 200 or 300 pounds to the square inch. The huge hydraulic presses that would crumple up a steel girder do not exert a pressure of more than 1,000 pounds to the square inch.

The only reason a gun barrel can resist this pressure (40,000 pounds to the square inch) is that it is built up in a series of concentric steel hoops of tubes shrunk one over the other until there is a resistance capacity of from 70,000 to 90,000 pounds to the square inch.

Even at rest, the barrels of these great guns are under such enormous compression, from being thus squeezed within these outer steel coverings that if the retaining steel jackets were suddenly cut the tubes would blow themselves into pieces from the violent reaction of release.

Not only does this smokeless powder burning inside these guns produce enormous pressure but it gene-

Pictures Obtained of Steel Projectiles Leaving Gun Muzzle at the Rate of 25 Miles a Minute

rates inconceivably great heat. Water boils at 100 degrees centigrade; iron melts at 1,400 degrees; platinum and the most resistant metals at 2,500 degrees; while the hottest thing on earth is the temperature of the electric arc, in which carbon boils.

This temperature is between 3,000 degrees and 4,000 degrees centigrade and is believed to be the same as that of these great powder chambers when the gun is fired. Thus a diamond, the hardest substance known, would melt in the barrel of a 12-inch gun at the moment of discharge.

The consequence is that at each discharge of a big gun a thin skin of metal inside the barrel is literally fused and this leads to rapid erosion of the softened surfaces under the tearing pressure of gases generated. The rifling is worn away, the band over the projectile becomes loose fitting and soon the huge gun, that has cost such a great sum, is rendered unfit for service.

The life of a 12-inch gun is only 450 rounds; that is, the gun would

be worn out if fired every three minutes for a single day. After that a new life may be given it by boring out the old tube and putting in a new steel lining.

A few words may be added about the formidable smokeless powder used in these great guns. This powder, in spite of its terrible power, is of innocent appearance and a small stick of it may be held safely in the hand while it burns with a vivid yellow flame.

There is no danger of its exploding or detonating like gun cotton and yet it is made from gun cotton, treated by a colliding process that is one of our jealously guarded military secrets.

There are foreign Governments that would give millions to know exactly how this powder is made and how it is preserved for years without deterioration. The destruction last year of two ships of the French navy was due, it is believed, to deterioration of their smokeless powder.

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WEST POINTERS' "SILENCE" SUGGESTED BY A WOMAN

IT was a woman who gave to West Point cadets the "silence," probably the most tantalizing yet dignified rebuke a student body can give a faculty officer. In no other college except Annapolis, which adopted the "silence" from the army boys, will anything approaching it in effect be found.

No one outside military life can estimate the crushing effect of this punishment. Without the least display the cadets show their displeasure in a manner that cannot be mistaken. A "silence" is the dread of every officer who serves at West Point. The memory of a "silence" clings to an officer through his career in the service. It is one of those somethings by which other officers appraise a new arrival at a post. The army never forgets the officer to whom the rebuke is administered, it being ac-

counted well for them to remain and be the cause of no more. Was the officer extended the invitation to never thought that he was making history—West Point history. The women remained to see the cadets dine after a strenuous day in the broiling sun.

Expecting the severe discipline noticed everywhere during the day, the women were surprised at the freedom of the cadets at supper. The hum of voices as the cadets talked and laughed over the happenings of the day was considered a breach of discipline by the schoolmaster from Annapolis.

"Nothing like this would be permitted in my class. Even the kindergarten children would not be given such free rein," was the remark of one teacher.

Other criticisms followed. This was all audible to the cadets at the nearest table. If a woman told an army man talk disrespectful of the corps. Though angered by the remarks, the cadets who overheard their table manners criticised did nothing to offend the women.

Unmindful of what he was doing, one of the young soldiers, who by the way is now one of the best known cavalry officers in the army, laid down his knife and fork, folded his arms and looked straight ahead. The other cadets at the table caught the idea and followed the example of the table captain. Cadets at nearby tables could not understand what had happened to their neighbors, all sitting severely erect, arms folded and their food still on their plates.

Something must be up, they thought, and training told them that an officer had been offered their friends and though they did not know what it was or who the offender was they followed the example of the cadets at the first table.

In less than five minutes after the criticism of the corps had been sent every cadet in the place was sitting as erect as a ramrod. The sound of voices had been replaced by a dead silence. Not a word was spoken.

The change had come, and that the school teachers realized something was wrong. Perhaps a demand had been given for perfect conduct, but when the eyes of several cadets were discovered staring at the teachers realized what was afoot and with flushed faces they slipped out of Culver Hall in a hasty and orderly retreat.

Two months later a student who had the same given officers was asked to do with the drilling and discipline of the corps, got into disfavor with the cadets because he made numerous and unexpected inspections and was strict and severe in carrying out the rules. His interpretation of the rules was not that of the cadets and some thing must be done to show the folly of his way. The old method of punishing an officer was to make him as they would do it and he would be in circumstances rolling cannon balls down stairs in the dead of night and not be carried out at that time.

The "silence" treatment visited on the school teachers was suggested.

How it would work out was never known until it was tried. When the cadets marched to supper a few minutes later this officer was in command of the mess. The cadets, however, the moral conversation was not in the doorway of the hall, but immediately conversation stopped, eyes and forks were laid aside and the cadets sat at attention without a word on parade.

The officer flashed. He had thought the school teacher might be a lawbreaker, but he was the victim of the punishment. It was a problem that had never faced before.

"Fall in!" he shouted and the corps came into the mess hall. He told the cadets he wanted to know those behind the plot to show him. But he got no answer and he knew no more that night.

A few months after the incident was sent on a special mission to the War Department's examination of the teaching officer from West Point. This was the beginning of the "silence." No student in the corps was able to find a better punishment than that which was used on the cadets nearly a quarter of a century ago by the Brooklyn schoolmaster.

The middle of August, 1914, and for trial on overpopulation. Only one instance is known where the silence not producing the desired result desired by the cadets.

About ten years ago a "silence" was given a Lieutenant and the "silence" prevailed during the general public were open to them. Everything about the academy was explained to them and in the museum the history of every battle scarred flag was told to them.

One of the sights at West Point is the mess hall. The schoolmaster's guide knew that white linen, glittering silver and glassware would appeal to women folks and he suggested that

MODERN CHARON OF NEW YORK'S RIVER STYX

HE is a modern Charon. Pilot of the little ship Fidelity, he ferries more than five thousand bodies a year over the River Styx to their last resting place. The River Styx in this instance happens to be the East River, New York.

Who is he? Capt. Michael J. Hayes, master pilot.

For more than seventeen years now, in the employ of the Charities Department of the city of New York, Capt. Hayes has been at the wheel of the little municipal ferryboat Fidelity, plying between East Twenty-sixth street and Hart's Island. He is a tall, angular Yankee, with one of those "don't know you but glad to meet you" smiles and a quiet, unostentatious manner. Twice a week every year of the seventeen Capt. Hayes has carried the unclaimed dead of the great city up the winding stream to that bare stretch of island known as potter's field.

"It's a kind of unpleasant business," remarked Capt. Hayes, "but you get used to it the same as you get used to everything else."

Every morning, rain or shine, winter or summer, the boat starts out on its tour of the various institutions along the East River, Blackwell's Island, with the workhouse; the Metropolitan Hospital, the City Hospital and the penitentiary. Ward's Island and the insane asylum, Riker's Island, the workhouse, Brother's Island with the home for incurables, Randall's Island and the Home for Feeble Minded Children, the Harlem Hospital and a number of others. And each day the little white boat receives its cargo of red rudely made boxes with their inert burdens, which it carries down the river again, at dusk, to deposit in the Morgue at Twenty-ninth street.

The bodies are left in the Morgue for a week or ten days, waiting for some one to claim them, and at the end of that time, if no one has done so, they are again put aboard the Fidelity and taken to potter's field. Twice a week Capt. Hayes makes the long trip up to Hart's Island, carrying an average of sixty bodies each trip. This means that there are about 120 persons a week, 480 a month, or 5,760 a year, who die in city institutions, unclaimed, friendless.

"Of course, we have more in the summer months," said Capt. Hayes as he leaned out of the window of the pilothouse and watched the deckhands trundling on the cargo. "There are more babies then, on account of the heat and bad nourishment, and so

on. We pick up bodies along the river too. They come up in the spring. One time we got three of them on three successive days, and all came up in exactly the same spot." The captain smiled a trifle ruefully. "They seem to know what the Fidelity is for."

All the puffing tugs and the stately steamers on the river recognize and respect the Fidelity, and various salutes were given across the waters as we steamed slowly along on our funeral mission.

We steamed on up the winding

"I might tell you she makes four-ton an hour if I wanted to make an impression," smiled Capt. Hayes when I asked him how fast the Fidelity went. "But as a matter of fact she can't do more than seven." He gave the wheel a spin and then turned toward me with a twinkle in his eyes. "She's been in this business for forty years now and there's never been any complaints from the passengers," he added.

We steamed on up the winding



Captain Michael J. Hayes.